

A LECTURE

16

ON THE IMPORTANCE OF A KNOWLEDGE OF

PHYSICAL SCIENCE

TO THE MEMBERS OF ALL PROFESSIONS,

BEING INTRODUCTORY TO

A COURSE OF LECTURES ON THE APPLICATION OF
ACOUSTICS TO THE DISCOVERY OF
CHEST DISEASES,

DELIVERED TO THE MEMBERS OF THE MEDICAL PROFESSION, AND OF
THE PHILOSOPHICAL INSTITUTION, AT BIRMINGHAM.

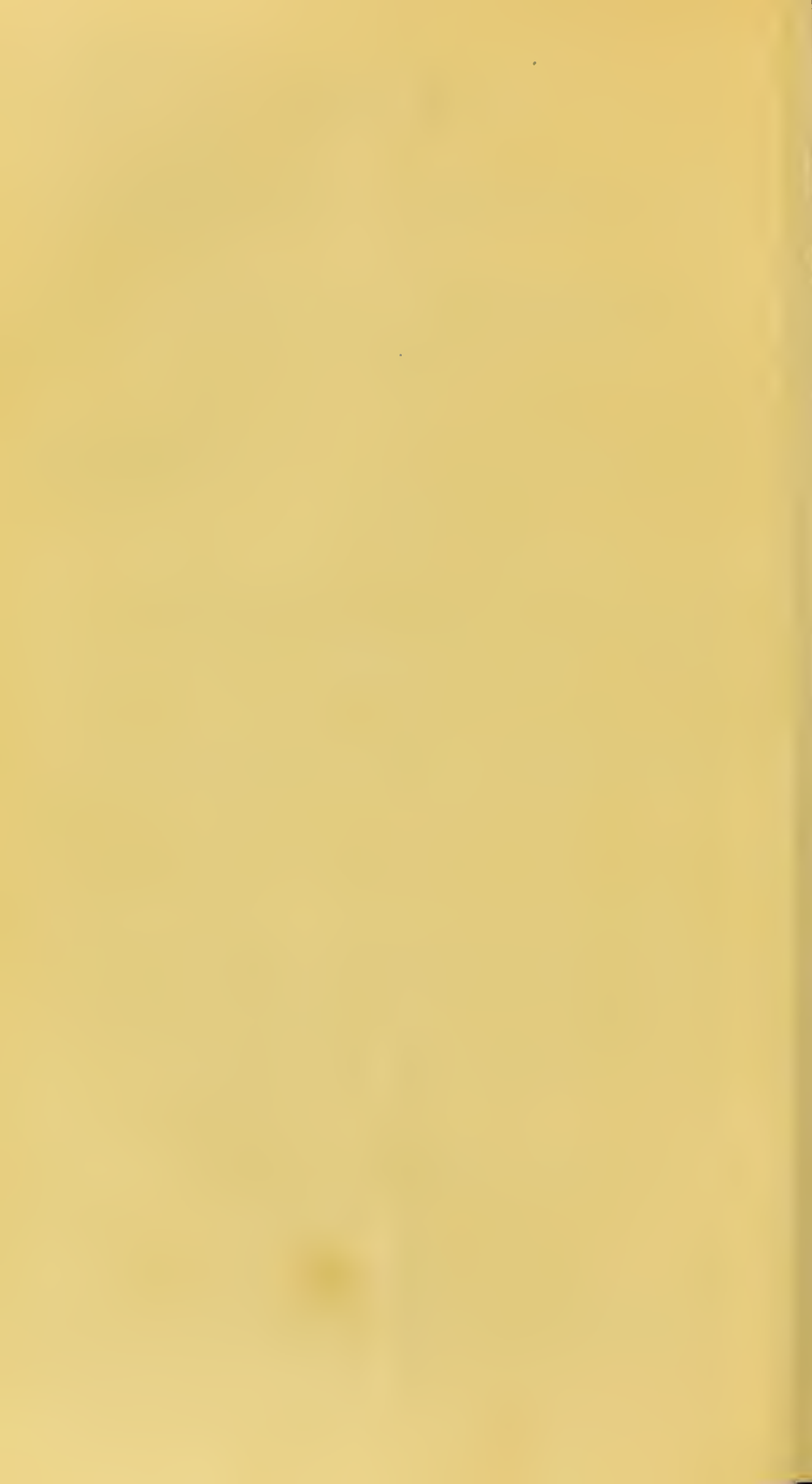
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THIS Lecture has been printed at the request of several Friends who were present at its delivery; and is intended for circulation among such young persons as are on the eve of entering a Profession, but more especially among those who have been in the habit of attending my Clinical Lectures at the Birmingham Dispensary.

It contains a few hints for their consideration, thrown loosely and hastily together; and therefore can only be regarded as offering a mere outline of the subject the filling up of which would swell these pages into a voluminous work, and would require the devotion of more time than I can command, and the exercise of more ability than I possess.

If its perusal shall excite an interest in the minds of any such persons, and shall encourage them in laying a solid foundation of scientific knowledge and religious principles for the formation of their professional character, I shall be highly gratified and amply rewarded.



LECTURE

ON THE IMPORTANCE OF A KNOWLEDGE OF PHYSICAL SCIENCE.

IN directing our attention to the practical application of any one branch of Physical Science to professional purposes, we are naturally led to enquire whether the study of Natural Philosophy in general, may not prove beneficial to members of *all* professions. To this enquiry I would address myself on the present occasion, not so much with a hope of laying any new or striking arguments before those who have previously considered the subject, as of arousing those who have hitherto been indifferent to it. Had it received that degree of attention to which it is entitled, I cannot but think that the important bearings of this Science upon all classes of society, would long since have been universally acknowledged, and that ample provision would have been made for its cultivation in our public schools, and a certain knowledge of it required in the examination for degrees at our great Universities.

We can hardly suppose that the classic groves would have proved less inviting to the student, had they been traversed by the stream of Science which reflects on its bright surface such varied and beautiful forms of Divine wisdom and goodness—that his imagination would have been less fitted to follow the bards of old, in their lofty aspirations and poetic visions, because new fields had been opened to it, by the contemplation of natural phenomena—that his mind disciplined to trace the causes and mutual dependance of these phenomena, would thereby have been rendered less capable of

entering into the subtle reasonings of the Philosophers of Greece and Rome—or that he would have been less roused by the sublime eloquence of their Orators, because he had been wont to listen to that Voice which speaks in all the operations of Nature. Nor can we suppose that his estimate of all that is noble and great in man would have been less just, had he been habituated, not merely to scan the actions of the warrior and the statesman, but also to follow those master spirits, who, at different times, have unravelled the laws by which the Universe is governed.

It is with pleasure, however, that we hail the commencement of improvement. The University of London has included Natural Philosophy among the subjects, a certain knowledge of which, is required from the candidates for medical degrees; and it is to be hoped that this example will soon be followed by other public bodies possessing the privilege of granting such degrees. In King's College, London, and in the University of Durham, classes have lately been formed for the purpose of educating students in the art of civil engineering, but in which all can acquire a sound knowledge of Physies; and in King Edward's school, in this place, measures have already been taken for giving instruction in some of the elementary branches of Natural Philosophy, which will doubtless be still further extended, as circumstances shall permit. Above all, in the University of Cambridge, a certain proficiency in these subjects is now required from all who present themselves for degrees in arts; while the examination of the aspirants for mathematical honors is such as to elucidate, not merely whether they are possessed of the mathematical knowledge necessary for working out the higher branches of Natural Philosophy, but whether they can and do use this knowledge; in short, whether they are Philosophers as well as caleulators.

As a better æra has thus commenced, it may be considered useless to touch upon the subject on this occasion: but, although the light has begun to dawn, the darkness has not been dispelled. There are parts of the globe on which, for a great portion of the year, the sun's rays do not fall; but the moon and stars afford that light which they have borrowed from the great luminary, and thus prevent the horrors of darkness. In a similarly subordinate character, I would

strive to assist those who have begun this work, and borrowing light from them, I would endeavour to increase the points of illumination, and thus bear my humble part in dispelling the darkness that has too long enveloped our systems of education.

I shall address myself principally to Students, in the hope of exciting in them a desire after scientific attainment, while they have time to devote to its acquirement; endeavouring to convince them of its importance to them, as regards both their future character and prospects; and also because this course may in some sort be considered as supplementary to that on Clinical Medicine, which, although interrupted by the preparation of the experiments required for the illustration of the course of Lectures on Chemistry, that I delivered lately to the Members of the Philosophical and Mechanics' Institution, I purpose resuming next year. Indeed the path of clinical instruction is one in which I consider it a duty to persevere, and with which no private engagements should be allowed to interfere; for the higher professional men rise, and the more extended their field of observation, the more imperiously are they called upon to devote some portion of their time to the improvement and instruction of the junior members of their profession, by imparting to them the results of their daily increasing experience. Few pleasures can be greater than those afforded by thus unfolding the enlarged views which are continually opening upon them, and seizing the opportunities offered by such intercourse with their pupils, to encourage in them those feelings of kindness, honour, and liberality, which they would wish to see possessed by those who may one day be placed side by side with them, in the practice of their profession. The beneficial effect produced on the minds of such teachers is truly astonishing; they are constantly stimulated to acute and accurate observation, they are led to ponder over the different cases which present themselves in the course of their practice, and to compare them with each other, watching closely every link in the chain of reasoning and in the deductions from them; and thus not unfrequently, unconnected and floating ideas will become fixed and certain principles. Sometimes they are led into a field of enquiry beyond that to which they had originally intended to direct their researches, an instance of which has occurred in the preparation of these Lectures, out of which has

arisen the discovery of some new facts connected with the theory of Sound.

This Course of Lectures has been opened to the Members of the Philosophical Institution, on account of the growing interest which is taken by all classes of society in physiological subjects, an interest which can hardly be too much fostered and encouraged. For were it to become general, and have the effect of inducing a large portion of educated persons to make themselves acquainted with the general economy of their frame, a vast improvement in the moral and physical condition of the human race might be expected to take place. The attention of such persons would be directed to the bringing up of their offspring, from the earliest age, on an uniform plan in respect to diet, clothing, and moral discipline, suggested to them by their physiological knowledge; whereby the lamentable effects on the health, lives, and disposition of the victims of parental caprice or indulgence, would be in some measure obviated, and a larger number of healthy and vigorous individuals would come to maturity. Seeing somewhat of the connection between the health of the body and that of the mind, and knowing that enervation of the latter must succeed to that of the former, whether induced by over-exertion or by luxurious indulgence; and that, on the other hand, loss of health must sooner or later follow the continuous and uncontrolled exercise of any bad passion, they would be induced to regulate their habits in such a manner as to preserve the mind and the body in a state of healthy equilibrium. But should disease attack them either in their persons or families, they would not be entirely devoid of the means of distinguishing between the empiric and the Philosopher, and would be enabled to assist the latter in carrying out those rational plans of treatment which he might adopt, the success of which often depends quite as much on the intelligence with which they are received and executed, as on the skill with which they have been devised.

It cannot be matter of surprise that many persons should take an unusual interest in the subject of these Lectures, and should desire to know the means whereby the various diseases of the chest are discovered and distinguished from each other, when we reflect that one-fifth of those who pay the debt of mortality, are

the victims of pulmonary consumption alone, that scourge of our large manufacturing towns. How insidious but how sure are the approaches of this devastating malady, gradually entwining its victims in its meshes, until it has woven around them a net from which no earthly power can extricate them! It is not a mere sweeping blast which whirls from the stem the petals of the more than matured flower, but it is the canker in the bud which gnaws around the half-developed leaves, and causes them to drop off almost as soon as their beauties have been revealed to the light. For here Death is dainty and fastidious in the selection of the victims he dooms for sacrifice. He grasps not the aged and infirm, who in the natural order of things lie nearest to his hand, but passes on to the young and beautiful, at the very period when their minds are expanding, and opening to new and fascinating views of prospective happiness. To make the sacrifice complete, the victim, decked with wreaths and garlands, is led to the altar unconscious of his impending fate; for how often in this disease does the eye glisten with unusual brightness, while the cheek is painted with the delicate bloom of the rose, and lighted up with the soft smile of hope that remains till the last! To all but its victim, this fatal malady tells its own tale, when it has reached an advanced period of its development; and although even then it may be wondrously suspended or altogether restrained, yet the extreme rarity of such results forbids our calculating on them with even an approach to certainty. In its earlier stages, however, much, I had almost said every thing, may be done in the way of prevention; who would not then rejoice to learn that there were means of detecting its approaches at such a period as to afford some hopes of their being arrested?

Persons thus interested will see here how the frame of the chest and the organs contained in it, are constructed; how their functions are performed, and the nature of those physical alterations which are produced in them by disease. They will learn somewhat of the laws of Physics, more especially Acoustics, most of which will be deduced from experiments performed under their eyes. They will thus understand in what manner physical alterations in the organs of respiration and circulation give rise to physical signs, which must be interpreted in accordance with the laws which govern matter in general; and will

be enabled to estimate at their true value, the assertions of those who would endeavour altogether to ridicule the application of the laws of Sound to the discovery of disease, or to deny its utility on the score of its difficulty in practice. As to the correctness of the principle, they will have ample means of satisfying themselves, and will find not merely that certain forms of disease *may* give rise to certain alterations of sound appreciable by the ear, but that they *must* do so. As to the difficulty of auscultation, they will remember that excellence is always difficult of attainment, but exertion is not on that account to be discouraged; and they will see that cases may occasionally occur, in which great doubts as to the nature of the disease will arise in the mind of the most skilful practitioner unhabituated to auscultation of the chest, wherein the merest novice in that art could hardly fail to form an accurate diagnosis.

The necessity of a knowledge of the laws of Physics to members of different professions, may be deduced as much from the observation of the evils which flow from a want of it, as from that of the beneficial effects produced by its application. To the former of these points I shall principally address myself at this time, reserving the latter for another occasion, when the general application of Scientific Knowledge to the useful purposes of life will be taken into consideration.

There are some professions in which the necessity for a knowledge of the laws of Physics is so obvious, that it would seem almost superfluous to urge it. How, for instance, could either the Civil Engineer or the Architect expect to practice their respective professions with credit to themselves, or with advantage to the community, without a competent knowledge of the laws which govern motion and equilibrium, light, heat, &c.? It is true that the mere surveyor may learn by rote certain rules laid down for him by others, and may apply them to the purposes of measurement; and the builder may do the same in regard to constructive carpentry; but the Engineer and Architect, whose minds are liable to be drawn upon in all emergencies, must have them so stocked with sterling knowledge of principles, as to be able to meet the drafts upon them by the quick and certain application of such knowledge to the necessities of each case. It is impossible to form an opinion as to the extent to which a want of this knowledge has acted in retarding the improvement of our social

state. Thus, is it not painful to think how much time and capital have been uselessly expended in exploring the bowels of the earth for metals or fuel, where none could possibly have existed? Had the mining Engineers not merely observed the crust of the earth and followed its stratification, but also possessed a knowledge of the laws of chemical action, heat, &c., they would much sooner have generalised their observations, and have been enabled to conduct their operations on fixed and certain principles. Again, although canals have been for a great number of years in use amongst us, it has but lately been discovered that great speed may be obtained on them, with proportionably less injury to their banks by the action of waves, which, under such circumstances, is found to be almost entirely obviated. Railroads, too, have now been some years in use, and yet but little is known as to the proportion between speed and locomotive power. Even in the construction of forge chimneys in this town, an absence of the knowledge of the commonest truths is exhibited. There is more than one in which a great fissure may be perceived when the fire passes up it. The whole of the brickwork being tied and bound in together, and the inner part of it expanding more than the outer, on account of its greater proximity to the heat, a rent is made; in the same manner as a thick glass tumbler is broken by the sudden pouring of hot water into it. Is it not truly lamentable to behold some of the most beautiful buildings in the world prematurely crumbling into ruin, when the stupendous Druidical remains of Stonehenge prove that the country contains materials which can for ages withstand the assaults of the elements? Recently, however, Science has been brought to bear upon this subject, by the appointment of Commissioners to determine upon the quality of the stone to be employed in the construction of the Houses of Parliament, and their report is an extremely valuable document. It is because the want has been felt in these branches, and the work of improvement has commenced in good earnest, that I do not pursue the subject further, although it might be shewn that in a thousand ways the want of a competent knowledge of Physical Science by the Engineer and Architect will appear, and that in a thousand ways the possession of it will be productive of utility and advantage in the daily practice of their respective professions.

I pass on to the profession of the Law, in the practice of which

instances are daily occurring wherein a knowledge of Natural Philosophy proves most valuable, and wherein its absence might entail serious consequences. A case once occurred arising out of an accident on the turnpike road. A gentleman driving a gig was met by a stage coach; a collision took place, and he was thrown out of his gig with great violence. A question arose as to whom the blame was attributable. It was argued by the driver of the gig that the coach was proceeding at a furious rate, and he instanced the distance at which he had been thrown as a proof of this. On the part of the coach proprietors it was proved that the gentleman was precipitated *a-head* of his gig, and then argued that the distance to which he was thrown was the exact measure of the velocity at which he was driving, and did not at all depend upon that of the coach. The gig being overturned and rendered stationary by coming in contact with the coach, a result which would have equally taken place had it struck against a post, the driver flew forward with the velocity at which he was before driving. The acquired velocity, multiplied by his weight, was the exact measure of the momentum with which he struck the ground. Just as when we urge a billiard ball along the table, we do not find it stop the moment we withdraw our hand from behind it; it moves on with a velocity proportioned to the momentum it had acquired at the time we ceased to urge it on, and it matters not to the velocity of the ball, whether our hand shall have been stopped by muscular exertion, or by coming in contact with a fixed obstacle. Such is one of the many cases which may come before a Court of Law, involving in them the principles of Natural Philosophy; and, inasmuch as the present advanced state of civilisation in this Country is mainly owing to the practical application of these principles, we may expect that every day they will become more involved and mixed up with those legal enquiries which increase in an almost geometric ratio with the advancement of society.

Nor is it less desirable that the Divine should make himself acquainted with Natural Philosophy. The unlettered peasant may read the book of nature to a certain extent, but how are its pages illuminated by the light of Science, what depth of thought does it not reveal, how does it clear the mind, and exalt our views of the Almighty Creator! I mean not a mere adeptness in mathema-

tical calculations, which, although it sharpens the intellect and strengthens the reasoning powers, does not enlarge the mind and touch the heart. The painter does not place his art in the mere handling of the pencil, in the painting of foliage, or in the figuring of drapery. True, he rejoices as he finds his dexterity in the use of his brush daily increasing, but it is only when he has employed it to embody and bring to light the visions of his mind, the creatures of his imagination, or the objects of his study in nature that he truly exults; and when by his last touches his figures are rounded into life, and made to swell out in relief from the canvass, when he has caused the mind to shine out through the countenance, then is he happy in the contemplation of his work, and he lives in the hope that others for ages to come, may read in it the workings of his own soul. Thus in applying mathematical calculations to unravel some of the Gordian knots which confine the truths of Science, we rejoice not so much in the skill with which we can unravel them (though there is a pleasure in this), as in the discovery of the previously hidden treasures which burst upon our view. The sublimity and wondrous contrivance they exhibit, give rise to a train of reflections which carries us beyond the present and which causes us to exclaim, in regard to things natural as well as those which are revealed, "Oh! the depth both of the knowledge and wisdom of God;" and the more we thus discover, the more irresistibly are we led to finish the sentence and say, "how unsearchable are His judgments, and His ways past finding out." Thus Natural Philosophy, while it exalts the character of the Almighty in our eyes, humbles us before Him. Sir John Herschel remarks, "The boundless views of intellectual and moral as well as material relations, which open on the Philosopher on all hands, in the course of these pursuits, the knowledge of the trivial place he occupies in the scale of Creation, and the sense continually pressed upon him of his own weakness and incapacity to suspend or modify the slightest movement in the vast machinery he sees in action around him, must effectually convince him, that humility of pretension, no less than confidence of hope, is what best becomes his character." This spirit of humility is the one of all others which should be anxiously sought by the Divine, both for himself and for those who look up to him for guidance and instruction. Somewhat of the same

feeling is excited in us, by perusing in the pages of history the actions of the mighty dead, and by viewing in our own and other countries, the works of living genius. While we acknowledge and feel their superiority, a longing desire comes over us to commune with such persons, and we should hail with infinite delight, any written communication from them, wherein we might read more of their mind, thoughts, and principles. Thus, too, when the wonders of the animal, vegetable, and mineral world open upon our view, an urgent desire is excited in our minds to receive a more direct communication from Him who ordereth all these things; and we turn with redoubled energy to the perusal of that sacred volume which contains a message from Him to each of us, which informs us of the relation in which we stand to Him, and of the manner in which He would have us regulate our conduct towards Himself and towards our fellow-creatures. Mr. Hare, in addressing the the Students of Trinity College, Cambridge, thus beautifully expresses himself, "You have often been advised to study the Mosaic Law for the types of Christ contained in it. You have often been recommended to examine the history of the Jews for the matters typical of Christ contained in it. Let me exhort you to search also for like types in another book, a book penned by the same hand which guided the inspired penmen of the Bible, the book of God's Creation. So you will learn to look at Nature as you ought to look, to discern something more than the ever-changing colours and ever-waving folds of her garments, to catch sight of those capital features in which her spirit is most visibly expressed, nay, to pierce through her body to her soul, or rather to behold the workings of her soul in all the movements of her body. So will you learn to discover something more than the mere properties of space and time, lines and numbers, in her laws. So will you learn to breathe life into the dry bones of your Natural Philosophy. To the godly, holding converse with Nature is holding converse with God. It is to them as another and a prior Bible; which, when man's secondary writing has been rubbed off, and when the original characters are brought out and deciphered and rightly interpreted, as with the help of the other they may be, unites from all its regions and spheres in declaring the glory of God, and in shewing His handiwork.....To what end indeed have we been endowed with

the creative faculty of the Imagination, which, glancing from heaven to earth, from earth to heaven, vivifies what to the eye seems lifeless, animates what to the eye seems torpid, combines and harmonises what to the eye seems broken and disjointed, and infuses a soul, with thought and feeling, with determinate purpose and submissive beneficence, into the multitudinous fantasmagoria of the senses? to what end, I ask, have we been so richly endowed? unless, as the prime object and appointed task of the Reason is to detect and apprehend the laws by which the Almighty Lawgiver upholds and rules the world he has created, it be in like manner the province and duty of the Imagination to be diligent in reading and studying the symbolical characters, wherewith God has engraven the revelations of His goodness on the interminable scroll of the visible universe. Both the one power and the other, when rightly employed, will be active and dutiful handmaids of Religion. They will enable us to recognise the traces of God's wisdom, of His goodness, and of His overruling providence, in all the objects around us, in the lowest, no less than in the highest. Thus to the truly pious mind all things become animated with a divine spirit. Whatever he sees is to him a memorial of God.* It being, then, the tendency of the study of nature and her laws, to humble us and to raise the character of the Almighty, drawing our minds up to Him, and leading us to seek to know more and more of Him through His revealed Word, of how great value must it be to the Divine, whose holy office it is to direct the feelings of his flock to heaven, "himself to lead the way" in this pursuit.

A different opinion has been maintained by some, ever since the time when Physical Science began to rear its head in this country, and even in these days its study is sometimes denounced as having a tendency to lead the mind away from the God of Revelation, and to fix it in the hopelessness of Infidelity. Such persons incur a serious responsibility, by endeavouring to prevent men from employing the faculties, with which their Maker has endowed them, in examining His works and in unravelling the laws by which it has pleased Him to regulate the Universe. Were this fear entertained by men who had themselves thoroughly investigated the truths of Science, and had experienced injurious effects upon their own minds, it would

* Sermons by the Rev. J. C. Hare, M.A., page 222.

indeed be a startling objection. But in vain we search for Natural Philosophers among the objectors to Physical Science, whose opinions are grounded on the observation of such effects on some others, and the fancied discrepancies between the discoveries of Science and the Word of God; while the most successful scientific enquirers have been in the number of those who have been distinguished alike for the nobleness of their sentiments and their pure and heart-felt piety. The fact is, that the name of Science, like that of the sacred love of liberty, is often assumed by men whose looseness of principle and immorality of conduct, has rendered them anxious to cheat their own consciences, and to pull down others to their own base level, striving to pollute the atmosphere of society in general with the same effluvia as that which floats around themselves; while the knowledge of the phenomena of Nature, on which they dare to question the authority of Revelation, is confined to that spurious "science falsely so called," which is sufficient to fill them with the arrogance of pretension, but cannot produce that humility which results from an accurate knowledge of the present state of any one branch of Natural Philosophy. There is, indeed, nothing pure or holy which may not be perverted to such vile purposes; but the great error seems to consist in mistaking the *pretext* for the *cause* of the evil. Rather than thus inveigh against these illegitimate uses of Scientific Knowledge, let us encourage its diffusion so widely, that it can no longer be made the mask under which the vicious and profane shall be able to act their hypocritical parts without the certainty of speedy detection. A *partial* knowledge might lead men to suppose that some of the discoveries of Science were at variance with the Word of God; but, when all its bearings and truths are thoroughly understood, it is found that the facts of both are in strict accordance with, and mutually confirmatory of each other; and if its study do not lead the mind to the God of Nature, and thence to the God of Revelation, then indeed must the fault lie in the constitution of that mind, and in its awful determination to choose "darkness rather than light, because its deeds are evil."

I now come to the profession of Medicine, the duty of the members of which is to preserve as long as possible the health and vigour of

the human frame, which, although under the influence of the vital principle, as well as the direction of a superior intelligence, is essentially a machine, the parts of which are all put together, and perform their various functions, according to the laws of Physics. Hence the importance of these laws being thoroughly understood by the medical practitioner. It is difficult to estimate how much the progress both of Astronomy and Medicine was retarded by the prevalence of the opinions of Aristotle and his followers, who supposed that the heavenly bodies and the animal frame were governed by laws peculiar to themselves, and distinct, as well from each other, as from those which affected the inanimate matter of the earth. Aretæus, one of the most accurate observers, whose descriptions of the signs of disease were singularly clear and graphic, has fallen into some of the most absurd notions that have ever offended against the common sense of mankind. Thus, in endeavouring to account for the uncertain and ever-varying forms of Hysteria, he supposes the organ affected to be a living creature which moves about from one part to another, and shifts continually the locality of the disease. Even in days much nearer our own, when Anatomy assumed the rank of a Science, and the separate parts of the human body were examined with care at the point of the scalpel, how many absurd theories appeared only to be succeeded by others equally ridiculous! And I think I shall be able to shew that the received opinions of the present day concerning the causes of some of the sounds heard in the human chest are diametrically opposed to the laws of Physics. Surely these errors could not have existed, had they who fell into them been acquainted with those laws.

It has been contended that the study of natural and pathological Anatomy will suffice to point out the nature of disease, inasmuch as the maker of a machine can soon discover and rectify any derangements in its movements. But the cases are not similar. The machinist can unmask and lay bare every part of his machine while in motion, which is far from being the case as regards the human body. The first indications of any derangement of its internal parts are furnished by irregularity in the functions they are destined to perform; and before this can be detected, the manner in which these functions are performed during health, must

be perfectly understood. Hence arises the study of Physiology, in which so many various matters enter, and in every part of which the laws of Physics and Chemistry are concerned. For there are in the human body joints of all kinds, levers, and pulleys; there are forces acting in all directions; there are fluids in motion, and a pneumatic apparatus constantly at work; there are arches and cylinders, pillars, and tubes. It contains the most perfect optical instrument in the world, the eye, which receives every species of impression conveyed by light, and through the medium of which the mind judges of every shade of colour, of dimension, and of distance. This body is often placed in a very variable climate, wherein the alternations of cold and heat are frequently occurring; and hence attention must be paid to habits, clothing, lodging, ventilation, &c., with a view to the preservation of that degree of heat which is best suited to the purposes of life generally, and the health of individuals particularly; and hence an acquaintance with the laws of heat, electricity, &c., is required. It may be considered, too, as a laboratory in which the most varied and numerous chemical operations are constantly going on. The study of Chemistry is now, I admit, encouraged and enforced; still students are too apt to limit their views of Chemistry to its effect upon the compounding and mixing of drugs; and the time is hardly passed away when the talent and skill of the Physician would have been estimated by many, in proportion to the chemical knowledge he displayed in grouping together different medicines in his prescriptions. But in truth the compounding of drugs is the smallest branch of those subjects to the proper understanding of which a knowledge of Chemistry is absolutely necessary. By Chemistry, in conjunction with Anatomy, is obtained a knowledge of the phenomena of digestion and assimilation. In the hands of Professors Tiedeman and Gmelin, it has been made to remove the veil with which these functions were so long covered, and to lay bare some of the inward workings of the body with the most wondrous precision and clearness. It is thus, and thus alone, that the true office of the liver has been ascertained, and proved to be subsidiary to that of the lungs; the former separating from the blood the excess of carbon and hydrogen in the shape of bile, which is not sufficiently carried off by the act of respiration as aqueous vapour and carbonic acid

gas. As regards the subject which is about to engage our attention in these Lectures, who can understand the physiology of respiration, without an acquaintance with the laws of equilibrium and motion, as applied both to solid and gaseous bodies? Who, that of circulation without knowing somewhat of the laws which govern liquids, both in a state of rest and motion? Even in this small field of our enquiry then, a knowledge of Pneumatics, Statics, Dynamics, Hydraulics and Hydrostatics is required. Who, again, would endeavour to reason upon the causes which tend to produce and modify the various sounds heard within the human chest, unless he knew something of Acoustics? And not only is a knowledge of Natural Philosophy required in the study of the healthy action of the parts which compose the human body, but it is of practical application in the discovery of disease, numerous instances of which will appear in this Course.

It may be said that for practical purposes the knowledge of Natural Philosophy is not required; because its application to each subject may be laid down in rules which can be easily acquired. To learn a profession thus by rules, of the formation of which we know nothing, is, to say the least, a very unsatisfactory mode of proceeding; and could only be recommended, I presume, under the idea that a saving of time would be effected: even on this ground, however, it cannot be defended, for the difficulty of remembering these rules is such, that they are constantly escaping the memory, till they are at length beaten into us by practice; and when lost, we have no clue to bring them back: in the same way as the Anatomy of books leaves us almost as soon as we have learnt it, while that which we have acquired by dissection is recalled to our recollection by a thousand remembrances of time and place. When a law of Natural Philosophy, however, is thoroughly understood and mastered by following its induction from experiment, it is acquired for ever; and although the rule of its application may escape us for a moment, yet the principle is the clue which speedily leads us right. Again, by studying a profession in the superficial way here alluded to, the utmost we can hope for is, to do as well as others have done before us. We cannot expect to advance the science of our profession, and to bear our part in detecting error and discovering new truths; for we should be crippled at every turn by our ignorance of first principles, and although our facts might be

accurately observed, our deductions from them might be hollow and unsound. The operative watch-maker may repair a watch, but he could not hope to make any grand discovery whereby its action could be improved, unless he knew the principles on which it was constructed; he might make compensation balance wheels, but he could hardly be expected to improve upon them unless he understood the principle upon which the compensation took place. Would you wish to be thus fettered and cramped? Have you never experienced an earnest desire to advance your profession? Have you never, when at times a suspicion of the unsoundness of this or the other opinion crossed your minds, have you never longed for the time when you might solve the doubt? When you have observed a want of knowledge in this or the other branch of your studies, have you never thirsted to discover the true spring? I ask, not whether you have sighed for applause, or wished that you had discovered some of the grand truths which have at different periods reflected glory on their discoverers; this feeling, the offspring of vanity, though more especially cherished by little minds, is more or less common to all; but I ask whether you have not often wished that the boundaries of the science of your respective professions should be enlarged, and determined that you would one day devote yourselves with zeal and energy to this great work? If so, you will begin by laying your foundation in a sound and thorough knowledge of the laws of Nature, as developed in the Universe around you: for this alone will give a proper direction and stability to your researches. To a mind, which however well-stored with general information and learning has no solid foundation of first principles, there is a constant feeling of restlessness and uneasiness, an infirmity of purpose, and a strange mixture of thoughts and projects; there is an unwillingness to enter upon any great field of enquiry or labour, from the consciousness that it is almost useless to be adding to a superstructure, the base of which is known and felt to be defective.

After all, it may be said that a course of such study would occupy more time than could be devoted to it by students. There would be some force in this objection were it necessary to go through a complete train of mathematical investigation; because this would require three or four years of unremitting and uninterrupted application. Happily this is unnecessary; for a very short time will suffice

to acquire such simple rules of arithmetic and elementary mathematics as shall enable us to comprehend the leading truths of Physical Science. On this subject the authority of Sir John Herschel is conclusive :— “There is scarcely any person,” he remarks, “of good ordinary understanding, however little exercised in abstract enquiries, who may not be readily made to comprehend at least the general train of reasoning by which any of the great truths of Physics are deduced, and the essential bearings and connections of the several parts of Natural Philosophy. There are whole branches too, and very extensive and important ones, to which mathematical reasoning has never been at all applied ; such as Chemistry, Geology, and Natural History in general, and many others in which it plays a very subordinate part, and of which the essential principles, and the grounds of application to useful purposes, may be perfectly well understood by a student who possesses no more mathematical knowledge than the rules of arithmetic ; so that no one need be deterred from the acquisition of knowledge, or even from active original research in such subjects, by a want of mathematical information. Even in those branches which, like Astronomy, Optics, and Dynamics, are almost exclusively under the dominion of mathematics, and in which no effectual progress can be made without *some* acquaintance with geometry, the principal *results* may be perfectly understood without it.”*

Enough has, I think, now been said to prove the direct advantages arising out of a study of Natural Philosophy by the student who desires to become thoroughly acquainted with the theory and practice of his profession, and to devote himself to original research ; but there are some indirect advantages also to which I am anxious to call your attention.

In the present day most persons of education know something of Natural Philosophy, and often form their opinion of a professional man from the degree of knowledge they find him possessed of on those points wherein their own information enables them to judge. They know that such knowledge is requisite for the proper study of a liberal profession ; should they, therefore, find him deficient in the ground work, they will necessarily be led to suspect the quality of the superstructure ; but should they, on the other hand, find him possessed of

* Discourse on the Study of Natural Philosophy, page 25.

a competent knowledge of those branches with which they themselves are familiar, they will be inclined to give him credit for the possession of professional knowledge of an equally sound and sterling quality. They would not go so far as to imagine that, because he was well-skilled in Natural Philosophy, he must, on that account, necessarily be a good Engineer, Lawyer, or Physician ; but they would certainly argue that he could not be such, without a competent knowledge of the important subjects which it embraces. They may possess other means of ascertaining the powers of his mind and his habits of application, but they are naturally anxious to know whether these have been employed by him in the practical duties of his profession ; and, as they can know nothing of these, they can only test this point on the neutral ground of Science which is common to him and them. And surely to be considered in the possession of Scientific Knowledge which you are daily in the habit of applying to the purposes of your profession, is no small step towards professional eminence. In short, the absence of scientific knowledge will sooner or later be detected, and injury to your prospects will result from such discovery ; while its presence will some day be perceived, and your character rise in proportion.

Again, by acquiring this knowledge during your pupilage, you will not only be better qualified to profit by the Lectures and instruction of those experienced teachers under whom you will be placed in the Metropolis, but you will be enabled, on engaging in the practice of your respective professions, at once to take a part in the diffusion of Scientific Knowledge, and will thus become useful members of the society among whom you are thrown, and will be employing a most legitimate and proper method of making yourselves known to, and respected by, the most influential and intelligent classes.

I am well aware that very different advice will be sometimes tendered to you, even by those who have your interest at heart, under a belief that a character for scientific attainment will not, in the slightest degree, contribute to your professional advancement ; and although they may not be desirous of restraining you from the study of Science during your pupilage, they will recommend you, when once you have entered on the practical duties of your profession, to devote all the time that remains, after these shall have been carefully performed, to the cultivation of the ac-

quaintance and patronage of such persons as may be likely to advance your interests in life. A little reflection will convince you that the tendency of such advice is ruinous. The line of conduct it recommends may succeed for a time, but it lays no solid foundation for a career which shall lead to eminence, and shall be dwelt upon with satisfaction by yourselves. It must be owned that some persons, eminently skilled in Science and Literature, both general and professional, have failed of success in practice; but this will be found to have arisen, in a great majority of cases, from certain deficiencies, either of manner or exertion, which none can afford to overlook. On the other hand, instances of pecuniary success, independent and irrespective of the slightest scientific acquirement, may be adduced. Such cases, happily, form the exception rather than the rule, and must necessarily occur in a Country where, after a profession is once entered upon, there is no further direct competition in which the prize is awarded to talent and learning; but where all is left to be decided by public opinion when the majority of persons are ignorant of those principles on a knowledge of which alone a sound opinion can be formed. I would not be supposed for a moment to underrate the advantages of urbanity of manner, and of careful forethought; but I maintain that to take a high standing in any profession, we must exhibit disinterestedness of character, candour of disposition, and generosity of sentiment; and must devote ourselves with ardour to the cultivation of those branches of Science which bear upon that profession, labouring daily in applying them to the elucidation of truth and the increase of sound and useful knowledge. And if we even go a step beyond this, and devote some small portion of our time to classical and literary pursuits, I have yet to learn, nor will I believe, that the Philosopher and the Scholar is less likely to meet with his reward than the person who would devote all his attention to forward his pecuniary prospects.

Although public facilities for acquiring Scientific Knowledge are, as yet, very limited, much may be learnt by Students who will assemble themselves together in small parties. In studying Mechanics, they may construct or procure small pieces of machinery which will illustrate the mechanical powers, the laws of equilibrium, gravity, &c. In Hydraulics, they can easily experiment on the motion and pressure

of fluids. Even in Chemistry much may be done at a very small cost. A medical student of this town who has a strong taste for Chemistry, and to whom I was indebted for much valuable assistance when engaged in my late Course of Lectures on that subject, having constructed his own machinery and apparatus, succeeded in making himself a thoroughly good and practical Chemist; and as a proof that these pursuits did not interfere with his other duties, I may mention that he has this year carried off the first prize in almost every department of medicine, at King's College, London.* There are, certainly, some branches of Experimental Philosophy in which costly apparatus is required. Such is usually to be found at the philosophical institutions of large towns, amongst whose members are often gentlemen of considerable scientific attainments, who would feel a pleasure in explaining the points which such apparatus is designed to illustrate. When thus associated together for the purpose of mutual improvement, you can hardly fail to meet with assistance and encouragement; and by devoting to philosophical enquiries those hours which too many spend in frivolous or vicious pursuits, you will be preserved from evil, and will be laying the foundation of future success and honourable distinction. So much for the student.

But it is no less necessary for those who are embarked in the practice of a profession to continue their studies in Natural Philosophy, or, if they have been neglected in early life, to commence them with vigour at a later period. When the mind and body are alike fatigued by arduous duties, how refreshing is it to turn to Experimental Philosophy, which affords a wholesome relaxation, at the same time that its successful cultivation renders us more fitted to advance the science of our respective professions!

It has been insinuated, that pure literary and scientific research is incompatible with the proper discharge of the practical duties of a profession, by intrenching on the time which should be devoted to them. If the greater part of our time were thus employed, there might be some truth in this; but happily, a very small portion of it regularly devoted to this object will enable us to keep up a moderate acquaintance with Literature and Science; and it must be remembered that some change of occupation is absolutely

* Mr. William Miller, since elected Chemical Demonstrator at King's College.

necessary to the mind. Is it not often found that the most distinguished authors have been among the most successful professional practitioners? Was Bacon less fitted to preside over a Court of Equity, because he was the father of inductive philosophy? or Sir Philip Sydney to command the armies, and assist at the councils of his Sovereign, because he was a sound and elegant scholar? Was Dr. Wells less calculated to investigate and treat disease with success, because he so beautifully discovered and worked out the theory of the dew? Was Bishop Watson rendered a less efficient vindicator of the Bible by being an accomplished Chemist? or did Charles Wolfe labour less devotedly among his parishioners in the north of Ireland, and was he less often found at the bed-side of poverty and sickness, spending himself in the service of his Divine Master, because he had cultivated his poetic genius, and had consecrated his talents to embalm the memory of one of England's greatest generals, in verses the most truly pathetic that have been produced in our language? It would not be difficult to show that some of the best contributions to Literature and Science in our own day have been furnished by gentlemen distinguished for the talent, industry, and zeal with which they discharge the duties of their respective professions, and in which they occupy most prominent positions. The study of Physical Science, so far from interfering with the practical duties of any profession, renders men more fitted to their task. Constantly habituated to trace the connection between cause and effect, and to deduce general laws from the observation of phenomena and of experiments, admitting no generalisations but such as are grounded on facts most faithfully and accurately observed, our minds become eminently practical, and we are enabled to draw sound and useful conclusions from the circumstances which daily present themselves to our view, with a clearness, rapidity, and precision, which are almost mistaken for intuition by a superficial observer, but which, in truth, are the natural accompaniments of a well-disciplined mind.

We are not only thus prepared for active duty, but our minds are enlarged and our hearts are improved; for who can contemplate the workings of Nature, and trace her unerring laws, without feeling an enlargement of mind, and increased benevolence of disposition? We are thus guarded from degenerating into heedlessness

and apathy, or from becoming narrow-minded and prejudiced; we are enabled to measure our own position with accuracy, and to take those comprehensive and philosophical views of our professional pursuits which alone can lead to any great and useful discoveries. Our hearts, too, are purified from those hateful feelings of envy and jealousy which are so apt to creep in; we cease to regard one another as contending rivals, but rather as fellow-workmen in one great cause, stimulating each other to active research by mutual encouragement and the interchange of observations bearing upon the subjects of our respective enquiries. We are thus led to use our utmost endeavours to prevent dissensions among our brethren, to heal the wounds which the thoughtless and cruel may have inflicted, to cheer up the despairing, and to bind all together in one solid and united body. While, however, we would, as much as possible, throw a veil over the failings and errors of others, we are not led into a hurtful extreme; but should we perceive dishonourable conduct, whether against, or on the part of any of our body, and should remonstrance fail, we should not hesitate boldly and openly to mark our sense of disapprobation, and thus uphold the dignity of our profession and our character.

By thus employing our leisure hours our minds are preserved in that calm and even state which is so essential to the proper discharge of our duties; neither dissipated by frivolous amusement, nor agitated by the excitement of political zeal. And if, as I have stated, the transition be easy from Natural to Revealed Religion; if, by a study of the former, which can hardly be separated from that of Natural Philosophy, the attention shall be more frequently turned to the latter, of how great value will our studies prove to us! for, to say nothing of the value of religion to us as individuals, there is no class of men on whom its influence is attended with more benefit to society at large, than the members of the professions of Medicine and Law. Sometimes they are placed in situations of such extreme delicacy, that the least wavering of principle would plunge whole families into the deepest sorrow. What better guarantee, then, can be offered for the maintenance of good principle, when that maintenance is of such value, than its religious foundation? It is the duty of the Physician, moreover, to watch the decay of the body, the gradual giving way

and final rupture of the tie that binds the spirit to earth; and although it be the especial province of the Divine to prepare it for its flight, yet are there times when the Physician can speak the words of caution or of comfort, when he may recall the thoughtless to a consideration of their state, and may raise the drooping spirit which is bowed down by bodily suffering.

We have now seen the importance of the study of Natural Philosophy to Engineers and Architects, and to the members of the professions of Divinity, Law, and Medicine; but I must go a step further, and affirm its importance to *all* members of society.

To what does this country owe its present place in the scale of nations, and its advanced state of civilisation, but to the discoveries which have, at successive periods, been made in Natural Philosophy? the practical application of which to the useful purposes of life (as instanced in the steam engine) has brought our peculiar resources into use, and has made us wealthy and powerful. Now have we attained the summit of the scale, or may we not expect to rise higher and higher by the same means? There is nothing in the history of past nations that should lead us to limit our expectations in these respects. The canker of slavery no longer preys upon our vitals from within, as it did in the palmy days of the ancient republics; nor are there any savages to pour in upon us from without, and extinguish our arts and sciences. What, then, shall stay our progress? Shall not each newly discovered spring of Scientific Knowledge be speedily turned into an useful channel, and swell the tide of civilisation which shall eventually sweep before it every obstruction raised by ignorance, and shall irrigate and enrich our Country? I do not mean to say that it shall flow in an uniform and uninterrupted stream; because while it is pursuing its course, and receiving force and magnitude from each tributary that joins it, there will necessarily be some back currents. Thus, we frequently see trade and prosperity transferred from some places in this Country to others, by improvements effected in the means of internal communication, as they were formerly in Europe by that of navigation. The time was when the treasures of the East were poured into the lap of Venice, when she sat as a swan upon the waters, rejoicing in the sun of her prosperity; but long since her proud bearing has departed; for a while she chaunted the death-note of her

expiring commerce ; and now she lies lifeless upon the waters, and is peopled only in imagination by the merchant princes of her former days. Obstacles, too, will oppose themselves to the career of civilisation, just as when the advancing waves of a stream are forcing a new channel before them, and pouring in upon a mass of matter hitherto compact, and dry. Ere it has been altogether broken up, huge fragments will be detached and thrown about with frightful violence and these at times uniting with each other will oppose a barrier to the advancing tide, threatening to turn it from its course, to deal destruction on all sides. But the more broadly they are opposed to the stream the sooner will they become moistened, and the longer they hold together the more complete will be their downfall when at length the accumulated force of the waters breaks them up, and crumbles them into a pulpy mire. Thus we see the progress of improvement interrupted, and society convulsed by restless agitators, who unite with each other to turn the course of knowledge from its proper direction, and to apply it to the levelling of the distinctions which have been raised by industry and talent, and to the disturbance of social happiness and order. Still, in spite of these obstacles and back currents, every year finds us more advanced, more wealthy, more powerful, better informed, and, I would fain hope, better conducted. When we see, too, that the truths of religion become extended in proportion to the increase of general knowledge ; that our ships carry with them to distant lands not only the produce of our industry, but the book of our faith and the expounders of its doctrines, we may surely hope that our advancement is of that good and solid kind that shall not be materially checked ; but that, while the increase of our Scientific Knowledge shall ensure our faith from the pollution of gross error and absurdities, and facilitate its diffusion both at home and abroad ; it shall in its turn, as it always has done, exert a direct and beneficial influence upon our prosperity and happiness.

Since, then, society has of late progressed, and may be expected to progress still further by the cultivation and application of Natural Philosophy, does it not become a self-evident proposition, that a knowledge of its principles is essential to a well-educated man ? We study the pages of history, and we endeavour to make ourselves

acquainted with the causes which have tended to the rise and fall of empires, and which have advanced or retarded the social condition of mankind; we direct our attention to the language, habits, and geographical position of various nations, and endeavour to trace the effects of different systems of legislation; and all with the avowed object of gaining experience from the past, that we may apply it to improve the state of society in our own generation. In this, doubtless, we do well; but are we not bound to go on still further, and to make ourselves acquainted with those principles of Science which under our very eyes are working such wondrous changes in our position? If we do not thus, we are like men shut up in a valley surrounded by inaccessible rocks; we live on from one day to another, neither bearing our part in the great work that is going on, nor knowing how others are carrying it on. Ignorant of the principles on which the improvement of our social state is taking place, we can neither assist in practically working it out among our neighbours, nor can we appreciate the labours of others in this cause. Borne to foreign countries, we are not in a situation to explore their natural products or to calculate their resources; and when we return home we can have but little information to impart, which will prove of the least value in bettering the condition of our countrymen.

In short, living as we do in an age and in a country wherein the application of Scientific Knowledge is the grand source of power, of wealth, and, to a certain extent, of happiness, we are called upon to go in advance of its stream which is so nobly rolling onwards, to clear away the obstacles which oppose themselves to its progress, and to facilitate its course through such channels as shall lead to the permanent welfare of mankind.

After all, perhaps, the most powerful motive for the cultivation of Physical Science is derived from the generous sentiments with which it inspires us. When we review our past feelings and actions, we often find that it is difficult to determine whether pleasure or pain has most predominated in the exercise of our intellectual powers; that our best efforts have sometimes been directed to unworthy objects; that when we have most deserved success it has been denied us, or that, when attained, its pleasure has fallen far short of our anticipations. But when all else fails, the improvement of the heart will

remain, and the consciousness of it yield an abiding and solid satisfaction. The time may come when the mind itself shall totter, when the imagination can no longer pierce the ideal world, when the reasoning faculties shall refuse their office, and memory shall be unable to use the accustomed key-words to unlock the trains of thought which they were intended to re-open. Amidst this melancholy decay of the mental faculties, and when the scientific acquirements of a long life are one by one departing, generosity of sentiment, their true and legitimate offspring, shall still remain; and being connected with a sure trust in Him whose works were the great objects of study and admiration shall hallow the latter days of the Natural Philosopher.

Let us remember, however, that the great improvement of the heart, its purification from self-love, is not a necessary consequence of having our *understandings* enlightened by the truths of Natural or even Revealed Religion. This can only be accomplished by the subjection of our *will* to that of our Maker. By this means alone shall we be enabled to exercise that self-denial and self-devotion from which are derived all the noble actions of the great and good. And we shall have our reward. "He who seeks after love in the spirit of self-sacrifice, will win love. He who seeks after glory in the spirit of self-sacrifice, will win glory. He who seeks after truth in the spirit of self-sacrifice, will win truth. At the same time he will have obtained a privileged immunity from all those anxieties and distractions and fears, from all those vain hopes and gnawing desires, and cankering jealousies and rancorous animosities, and from that undying worm of envy, of which selfishness is the sole and prolific parent. Misfortune cannot befall him. Evil cannot touch him. Death cannot harm him. He has already passed through the gates of immortality."*

* Sermons by the Rev. J. C. Hare, page 275.



